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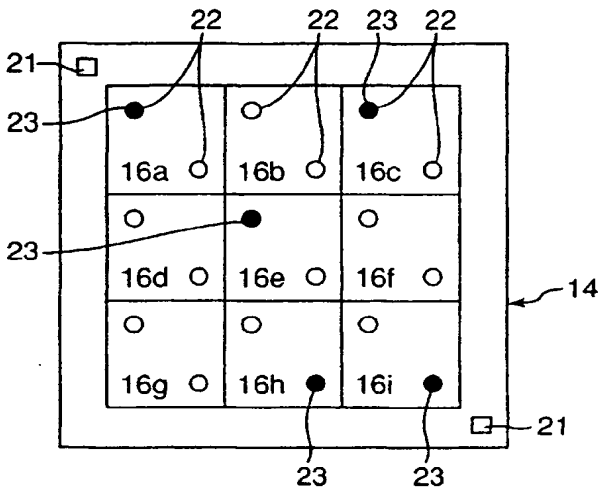
(54) Component-mounting method and component-mounting apparatus

(57) The number of recognition operations for the circuit-formed substrate (14) as a whole is reduced by concurrently recognizing a bad mark (23) and an individual substrate mark (22) in the course of a recognition process of a single or a plurality of individual substrate (s) (16) provided by sectioning the circuit-formed substrate (14). The results of the recognition of the inclination and dislocation of the circuit-formed substrate (14) are used to control the position of the substrate-recognition camera (15) which recognizes the individual substrate (15), thereby reducing the rate of occurrence of recognition errors. When a component of the recognition marks (21) or (22) is captured within the visual field (31) of the substrate-recognition camera (15), the position of the recognized marks (21) or (22) is specified, and such a mark is again recognized, and thus, the occurrence of recognition error can be inhibited.

Fig.1A



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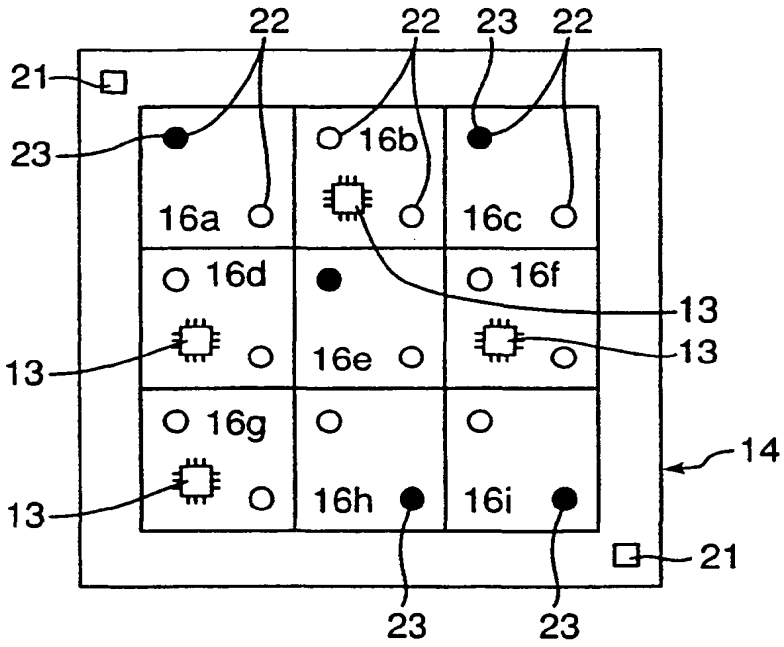
(Cont. next page)

Fig.1B



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a method for mounting components such as electronic components, etc. on a circuit-formed substrate such as an electronic circuit board, and a component-mounting apparatus for carrying out the component-mounting method.

[0002] Fig. 6 shows an outline of a whole of a conventional component-mounting apparatus (1). In Fig. 6, the component-mounting apparatus (1) comprises, as main components, a component-feeding unit (2) composed of a cassette type component-feeding device for feeding components such as electronic components or the like; a tray-feeding unit (3) composed of a tray type component-feeding device; a mounding head (4) equipped with a plurality of nozzles for taking components out of both feeding units (2, 3) and mounting them on a circuit-formed substrate; an XY robot (5) for carrying the mounting head (4) to a predetermined position; a component-recognition camera (6) for recording and recognizing the condition of a component held by a nozzle of the mounting head (4); a circuit-formed substrate-securing device (7) for carrying the circuit-formed substrate to the component-mounting apparatus (1) and securing the same; and a control unit (9) for controlling the operations of a whole of the component-mounting apparatus.

[0003] With reference to Fig. 6, a cassette type component-feeding device (8) having a reel onto which a lot of components are tape-like wound up is set on the component-feeding unit (2). A tray pallet type component-feeding device (10) on which a lot of components are arrayed is set on the tray-feeding unit (3). The mounting head (4) is equipped with nozzle heads (11) each having a nozzle (12) for sucking and taking a component (13) out of the component-feeding unit (2) or the tray-feeding unit (3). The angle of each nozzle (12) can be corrected by rotating on an axis Z by means of a rotation-controlling mechanism (θ rotation). The X-Y robot (5) carries the mounting head (4) on a plane in X- and y-directions. The circuit-formed substrate-securing device (7) carries and secures the circuit-formed substrate (14) such as an electronic circuit substrate or the like. The mounting head (4) is equipped with a substrate-recognition camera (15) for recording and recognizing the condition of the circuit-formed substrate secured.

[0004] The component-mounting apparatus (1) thus constructed is operated as follows. The mounting head (4) moves just above a component (13) fed by the component-feeding unit (2) or the tray-feeding unit (3) and causes each of the nozzles (12) to lower to contact and suck the component (13) and take it out of the component-feeding unit (2) or the tray-feeding unit (3), utilizing a negative pressure. Next, the mounting head (4), sucking and holding the component (13) at each of the nozzles (12), is carried by the X-Y robot (5) to a position facing to the component-recognition camera (6). The component-recognition camera (6) records and recognizes the component (13) sucked and held by each nozzle (12) of the mounting head (4) while the mounting head (4) is passing through the position facing to the component-recognition camera (6) at a predetermined speed. The inclination of the component (13) and a dislocation of the position thereof are measured based on the result of the above recognition.

[0005] The circuit-formed substrate (14) is carried by the circuit-formed substrate-securing device (7) and then regulated and secured at a predetermined position. When the mounting head (4) is moved to a position facing to the circuit-formed substrate (14), the substrate-recognition camera (15) provided on the mounting head (4) records and recognizes the circuit-formed substrate (14). The inclination or dislocation of the circuit-formed substrate (14) is measured based on the result of the recognition. The control unit (9) instructs, to each of the nozzle heads (11) mounted on the mounting head (4), a correction amount of the position and inclination of the component (13) based on the position, inclination and dislocation of the circuit-formed substrate (14). Each of the nozzle heads (11) corrects the position and inclination of the component (13) according to the instruction, and then mounts the component (13) at a predetermined position on the circuit-formed substrate (14).

[0006] Fig. 7A is a view through the substrate-recognition camera (15) provided on the mounting head (4), showing the condition of the circuit-formed substrate (14) regulated and secured. In this regard, one sheet of circuit-formed substrate (14) may compose a single electronic circuit substrate. However, in association with recent electronic devices with small sizes and light weight, downsizing of electronic circuit substrate is demanded, and thus, in many cases, a single circuit-formed substrate (14) is sectioned to provide a plurality of electronic circuit substrates as shown in Fig. 7A. In the example shown in Fig. 7A, the circuit-formed substrate (14) is sectioned for 9 individual substrates (16a) to (16i) which are arrayed in 3 rows and 3 columns. It may be sectioned for more individual substrates, for example, several tens of substrates. In the present specification, a whole of one sheet with an original size is referred to as the circuit-formed substrate (14), and any of specified and individual substrates (16a) to (16i) is denoted by using an individual reference number or notation. Further, when not a specified individual substrate but the plurality of individual substrates provided from one circuit-formed substrate are generally referred to, such individual substrates are called individual substrates (16).

[0007] As shown in Fig. 7A, generally, a pair of reference marks (21) are provided at and around the corners on a diagonal line of the circuit-formed substrate (14). The substrate-recognition camera (15) recognizes both reference marks (21) of the circuit-formed substrate (14) being regulated and secured by the circuit-formed sub-

strate-securing device (7), and the inclination of the circuit-formed substrate (14) and dislocation of the position thereof are measured based on the result of the recognition. The inclination of the circuit-formed substrate (14) and the dislocation of the position thereof are included in the correction amounts for the inclination of the component (13) and the dislocation of the position thereof when the component (13) is mounted.

[0008] On the other hand, generally, a pair of individual substrate marks (22) are provided at and around the corners of a diagonal line of each of the individual substrates (16). The component (13) itself becomes smaller in association with the downsizing of electronic devices as mentioned above, and thus, the component-mounting density becomes higher. Therefore, it is required to accurately mount the components at predetermined positions without any interference with other components which have already been mounted. The individual substrate marks (22) are used to make accurate positioning of components on each individual substrate (16).

[0009] In addition to the individual substrate marks (22), a position for indicating a bad mark (23) is provided on the individual substrate (16). If some factors for failure such as incorrect mounting or non-mounting occur on a specified individual substrate (16) in any step of the process of mounting components on the circuit-formed substrate (14), a bad mark (23) is indicated on the relevant individual substrate (16). Generally, an operator or an automatic machine puts a bad mark (23) by coloring it using a black ink or the like when finding a failure in the course of an intermediate inspection step or the like. This bad mark (23) is recognized by the substrate-recognition camera (15) based on the occupation ratio of brightness (white and black are grasped based on their proportion by a binary value level). An individual substrate (16) attached with the bad mark (23) does not undergo a later component-mounting process so as to save useless consumption of components and loss of tact time.

[0010] The arrows of the broken line shown in Fig. 7A indicate the passage along which the substrate-recognition camera (15) recognizes the bad marks (23). The recognition passage starts from the recognition of the bad mark (23) on the individual substrate (16a), followed by the bad marks (23) on other individual substrates (16b, 16c) on the same row, further followed by the bad mark (23) on the individual substrate (16d) in the next row, and the recognition is carried out in the same manner up to the final individual substrate (16i). In the example shown in Fig. 7A, bad marks (23) are put on the individual substrates (16a, 16c, 16e, 16h, 16i), respectively. Fig. 7B shows the passage of recognizing the individual substrate marks (22) after the recognition of the bad marks (23). Also, in this recognition passage, as indicated by the arrows of the broken lines, first, a pair of the individual substrate marks (22) of the individual substrate (16a) are recognized, followed by the individual substrate marks (22) of the individual substrates (16b) to (16i) in order.

[0011] Fig. 8 shows a flowchart of recognition operation by the substrate-recognition camera (15). In Fig. 8, the substrate-recognition camera (15) is moved to a position facing to the circuit-formed substrate (14) in accordance with the movement of the mounting head (14), and the substrate-recognition camera (15) first recognizes the reference marks (21) at 2 positions of the circuit-formed substrate (14) at Step 51. In an actual recognition operation, the substrate-recognition camera (15) first takes up the image of the reference mark (21) at the first point into CCD. This image is inputted to the control unit (9) and stored therein. Next, the camera (15) recognizes the image of the reference mark (21) at the second point and takes it into CCD and inputs this image to the control unit (9) and stores therein. The inclination of the circuit-formed substrate (14) and dislocation of the position thereof are measured based on the result of the recognition of both reference marks (21) at the two points. Next, at Step 52, the camera (15) sequentially recognizes the bad marks (23) on the individual substrates (16) provided by sectioning the circuit-formed substrate (14) (total 9 points in the example shown in Fig. 7). As mentioned above, the data of the individual substrates (16) on which the bad marks (23) have been recognized are inputted to the control unit (9) so as not to undergo a later component-mounting step.

[0012] Next, at Step 53, the substrate-recognition camera (15) sequentially recognizes the paired individual substrate marks (22) on overall individual substrates (16) provided by sectioning the circuit-formed substrate (14) (18 points in total in the example shown in Fig. 7). The results of the recognition of the individual substrate marks (22) are inputted to the control unit (9) so as to be reflected on correction amounts for an inclination and a position of a component to be mounted in the later component-mounting step. After that, the component-mounting operation is carried out at Step 54, and the component (13) sucked by each of the nozzles is mounted on a predetermined position of each of the individual substrates (16).

[0013] However, the conventional component-mounting method as mentioned above has problems as follows. That is, in the operation of recognizing the individual substrates (16), first, the recognition of the bad marks (23) are carried out (Step 52 of the flowchart shown in Fig. 8), followed by the recognition of the individual substrate marks (22) (Step 53 of the same flowchart), and therefore, a lot of recognition operations as a whole are required, and long time is required for such a lot of recognition operations, which may adversely influence on a case of a circuit-formed substrate (14) which is sectioned into several tens of individual substrates. For example, in case of a circuit-formed substrate (14) sectioned into 77 individual substrates, as many as 231 times of recognition operations in total are required for a single circuit-formed substrate (14).

[0014] Next, the inclination of the circuit-formed sub-

strate (14) and dislocation of the position thereof are recognized based on the results of the recognition of a pair of reference marks (21) on the circuit-formed substrate (14), and the results of this recognition are used in the calculation of the correction amounts for the inclination of the component (13) and the position thereof. However, a recognition error may occur in the course of the operation of recognizing the individual substrate marks (22) on each of the individual substrates (16), depending on the degree of the inclination of the circuit-formed substrate (14), and thus, in some cases, the result of recognition of the reference marks (21) of the circuit-formed substrate is not effectively utilized. Fig. 9 shows one of such situations, in which, as indicated by the arrow of the broken line (25), a pair of reference marks (21) of the circuit-formed substrate (14) are first recognized by the substrate-recognition camera (15), and the inclination of the circuit-formed substrate (14) and dislocation of the position thereof are measured based on the results of the recognition. These results are used for calculation of correction amounts for the inclination of a component (13) to be mounted and dislocation of the position thereof.

[0015] In review of each of the individual substrates (16), for example, the recognition of the individual substrate marks (22) of the individual substrates (16a, 16b) has no failure because the individual substrate marks (22) of the individual substrates (16a, 16b) are included in the visual field (31) of the substrate-recognition camera (15). In contrast, for example, in case of the individual substrate (16c), a component of the individual substrate mark (22) indicated by the circle is excluded from the visual field (31) of the camera (15) indicated by the square, which results in a recognition error. Such recognition errors similarly occur in case of the individual substrates (16f, 16g, 16h, 16i). If such a recognition error occurs, the following process may be optionally determined. However, correction amounts for the inclination and position of a component (13) can not be determined if such a recognition error is left unsolved. Therefore, the individual substrates (16) having such recognition errors have conventionally been judged as defectives. The individual substrates (16) judged as defectives are not subjected to the following component-mounting step. In other words, the individual substrates (16) which may be originally non-defectives are judged as defectives and are scrapped, depending on the inclination of the circuit-formed substrate (14).

[0016] To solve the problem induced by the above recognition error, it is proposed to widen the visual field of the substrate-recognition camera (15). However, this solution has a problem in that, generally, the resolution of the camera degrades if the visual field of the camera is widened, which leads to a further problem that the tact time becomes longer because the recognition of an individual substrate requires longer time. In addition, there is a danger of degrading the accuracy of recognition determined by the occupation rate of brightness mentioned above, because, by widening the visual field of the camera (15), other factors may be included in the visual field of the camera (15) and because such factors may be recognized by mistake. At present, on the contrary, there is a tendency of narrowing the visual field of a recognition camera to improve the resolution of the camera and to thereby reduce recognition time, so as to improve production efficiency. However, narrowing the visual field means more frequent occurrence of the foregoing recognition errors, which leads to a decrease in the yield of non-defectives.

[0017] Objects of the present invention are, therefore, to provide a component-mounting apparatus which is free from the above problems in the recognition operations of the circuit-formed substrate (14) of the conventional apparatus and which can carry out efficient recognition operations to increase the yield of non-defectives and to thereby improve the productivity, and to provide a component-mounting method.

SUMMARY OF THE INVENTION

[0018] The present invention provides a method of mounting a component, which comprises the steps of recognizing a bad mark which is indicated on a circuit-formed substrate when each of at least one individual substrate provided by sectioning the circuit-formed substrate includes a defective individual substrate, and an individual substrate mark which is provided on the circuit-formed substrate so as to recognize the position and the inclination of each of at least one individual substrate as above; and mounting a component on the circuit-formed substrate, aiming at an individual substrate having no bad mark indicated; and the invention is characterized in that the bad mark is indicated on the individual substrate mark. This method is effective to improve the efficiency of the recognition operation by using the individual substrate mark also as the bad mark.

[0019] Another aspect of the present invention provides a method for mounting a component, which comprises the steps of recognizing the condition of a sucked component which is fed by a component-feeding device, sucked and taken out; recognizing the condition of a secured circuit-formed substrate which is carried, regulated and secured; recognizing the position and the inclination of at least one individual substrate provided by sectioning the circuit-formed substrate; calculating correction amounts for the position and inclination of the component to be mounted, based on the result of the recognition of the component-sucking condition, the result of the recognition of the circuit-formed substrate-securing condition, and the result of the recognition of the position and inclination of the individual substrate; and making necessary correction on the component based on the result of the above calculation, and mounting the component at a predetermined position on the individual substrate; and the invention is characterized in that a mark which is provided on the individual sub-

strate so as to recognize the position and inclination of the individual substrate is used also as a bad mark for discriminating a defective individual substrate. This method is effective to reduce the number of the recognition operations by the substrate-recognition camera, by using the individual substrate mark also as the bad mark.

[0020] Another aspect of the present invention is characterized in that the bad mark is indicated by coloring the individual substrate mark of an individual substrate which is judged as a defective before mounting a component.

[0021] Another aspect of the present invention provides a method for mounting a component, which comprises the steps of recognizing the condition of a sucked component which is fed from a component-feeding unit, sucked and taken out; recognizing the condition of a secured circuit-formed substrate which is carried, regulated and secured; recognizing the position and inclination of at least one individual substrate provided by sectioning the circuit-formed substrate; calculating correction amounts for the position and inclination of the component to be mounted, based on the results of the recognition of the component-sucking condition, the circuit-formed substrate-securing condition, and the position and inclination of the individual substrate; and making necessary correction on the component based on the result of the above calculation, and mounting the component at a predetermined position on the individual substrate, and the invention is characterized in that a position at which a substrate-recognition camera should recognize the position and inclination of the individual substrate is controlled based on the result of the recognition of the circuit-formed substrate-securing condition. This method is effective to avoid occurrence of a recognition error by utilizing the inclination of the circuit-formed substrate and the dislocation of the position thereof for the recognition operation of the individual substrate.

[0022] Another aspect of the present invention provides a method for mounting a component, which comprises the steps of recognizing the condition of a sucked component which is fed from a component-feeding unit, sucked and taken out; recognizing the condition of a secured circuit-formed substrate which is carried, regulated and secured; recognizing the position and inclination of at least one individual substrate provided by sectioning the circuit-formed substrate; calculating correction amounts for the position and inclination of the component to be mounted, based on the results of the recognition of the component-sucking condition, the circuit-formed substrate-securing condition, and the position and inclination of the individual substrate; and making necessary correction on the component based on the result of the above calculation, and mounting the component at a predetermined position on the individual substrate; and the invention is characterized in that, when a portion or a whole of a mark provided on the circuit-formed substrate so as to recognize the circuit-formed substrate-securing condition or a mark provided on the individual substrate so as to recognize the condition of the individual substrate is not included within the visual field of a substrate-recognition camera for recognizing these marks, the position of the mark is detected and the mark is again recognized. This method is effective to improve the yield of the non-defectives by detecting the position of the mark and again recognizing the same mark, even if a recognition error occurs.

[0023] Another aspect of the present invention is characterized in that the position of the mark is detected based on a potion of the mark captured within the visual field of the substrate-recognition camera, and that the mark is again recognized by moving the visual field of the substrate-recognition camera to the detected position.

[0024] Another aspect of the present invention is characterized in that the position of the mark is detected by enlarging the visual field of the substrate-recognition camera, and that the mark is again recognized.

[0025] Another aspect of the present invention provides a component-mounting apparatus which comprises a component-feeding unit for feeding a component to be mounted; a mounting head for taking the component out of the component-feeding unit and mounting it on a circuit-formed substrate; a component-recognition camera for recognizing the condition of the component held by the mounting head; an X-Y robot for carrying the mounting head to a predetermined position; a circuit-formed substrate-securing device for carrying and securing the circuit-formed substrate; a substrate-recognition camera for recognizing the condition of the secured circuit-formed substrate; and a control unit for controlling the overall operations of the apparatus. With the above construction, the substrate-recognition camera recognizes an individual substrate mark which is provided on each of at least one individual substrate provided by sectioning the circuit-formed substrate so as to recognize the position and inclination of the individual substrate; correction amounts for the position and inclination of the component to be mounted are calculated based on the result of the recognition of the individual substrate mark, the result of the recognition of the component-holding condition by the component-recognition camera, and the result of the recognition of the circuit-formed substrate-securing condition by the substrate-recognition camera so as to make necessary correction on the component; and the mounting head is carried by the X-Y robot so as to mount the component at a predetermined position on the individual substrate; and the invention is characterized in that a bad mark to be indicated when the circuit-formed substrate includes a defective individual substrate is put on an individual substrate mark of the defective individual substrate so that the substrate-recognition camera can recognize the bad mark at the same time when recognizing the individual substrate mark. The use of this apparatus is effective to

improve the efficiency of the recognition operation by using the individual substrate mark also as the bad mark.

[0026] Another aspect of the present invention provides a component-mounting apparatus which comprises a component-feeding unit for feeding a component to be mounted; a mounting head for taking the component out of the component-feeding unit and mounting it on a circuit-formed substrate; a component-recognition camera for recognizing the condition of the component held by the mounting head; an X-Y robot for carrying the mounting head to a predetermined position; a circuit-formed substrate-securing device for carrying and securing the circuit-formed substrate; a substrate-recognition camera for recording and recognizing the condition of the secured circuit-formed substrate; and a control unit for controlling the overall operations of the apparatus. With the above construction, the substrate-recognition camera recognizes an individual substrate mark which is provided on each of at least one individual substrate provided by sectioning the circuit-formed substrate so as to recognize the position and inclination of the individual substrate; correction amounts for the position and inclination of the component to be mounted are calculated based on the result of the recognition of the individual substrate mark, the result of the recognition of the component-holding condition by the component-recognition camera, and the result of the recognition of the circuit-formed substrate-securing condition by the substrate-recognition camera so as to make necessary correction on the component; and the mounting head is carried by the X-Y robot so as to mount the component at a predetermined position on the individual substrate; and the invention is characterized in that a position at which the substrate-recognition camera should recognize the individual substrate mark is controlled based on the result of the recognition of the circuit-formed substrate-securing condition. This apparatus makes it possible to avoid such a situation that the individual substrate mark is not recognized at all, as much as possible, by controlling the position of the substrate-recognition camera based on the result of the recognition of the position and inclination of the circuit-formed substrate.

[0027] Another aspect of the present invention provides a component-mounting apparatus which comprises a component-feeding unit for feeding a component to be mounted; a mounting head for taking the component out of the component-feeding unit and mounting it on a circuit-formed substrate; a component-recognition camera for recognizing the condition of the component held by the mounting head; an X-Y robot for carrying the mounting head to a predetermined position; a circuit-formed substrate-securing device for carrying and securing the circuit-formed substrate; a substrate-recognition camera for recording and recognizing the condition of the secured circuit-formed substrate; and a control unit for controlling the overall operations of the apparatus. With the above construction, the substrate-recognition camera recognizes an individual substrate mark which is provided on each of at least one individual substrate provided by sectioning the circuit-formed substrate so as to recognize the position and inclination of the individual substrate; correction amounts for the position and inclination of the component to be mounted are calculated based on the result of the recognition of the individual substrate mark, the result of the recognition of the component-holding condition by the component-recognition camera, and the result of the recognition of the circuit-formed substrate-securing condition by the substrate-recognition camera so as to make necessary correction on the component; and the mounting head is carried by the X-Y robot so as to mount the component at a predetermined position on the individual substrate; and the invention is characterized in that, when a portion or a whole of a reference mark provided on the circuit-formed substrate for recognizing the circuit-formed substrate-securing condition, or an individual substrate mark is not included within the visual field of the substrate-recognition camera, the substrate-recognition camera detects the position of the mark and again recognizes the same mark.

[0028] Another aspect of the present invention is characterized in that the position of the mark is detected based on a portion of the mark captured within the visual field of the substrate-recognition camera, and that the mark is again recognized by moving the visual field of the substrate-recognition camera to the detected position.

[0029] Another aspect of the present invention is characterized in that the position of the mark is detected by enlarging the visual field of the substrate-recognition camera, and that the detected mark is again recognized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Figs. 1A and 1B are plan views of a circuit-formed substrate according to an embodiment of the present invention;

Fig. 2 is an operation flowchart of a process of recognition of the circuit-formed substrate shown in Fig. 1;

Fig. 3 is a plan view of a circuit-formed substrate according to another embodiment of the present invention, illustrating a process of recognition thereof;

Figs. 4A and 4B are plan views of a circuit-formed substrate according to other embodiment of the present invention, illustrating a process of recognition thereof;

Fig. 5 is an operation flowchart of the process of recognition of the circuit-formed substrate shown in Fig. 4;

Fig. 6 is a perspective view of a conventional component-mounting apparatus;

unit, sucked and taken out,
recognizing the condition of a secured circuit-formed substrate which is carried, regulated and secured;
recognizing the position and inclination of at least one individual substrate provided by sectioning the circuit-formed substrate;
calculating correction amounts for the position and inclination of the component to be mounted, based on the results of the recognition of the component-sucking condition, the circuit-formed substrate-securing condition, and the position and inclination of the individual substrate; and
making necessary correction on the component based on the result of said calculation, and mounting the component at a predetermined position on the individual substrate;

wherein a position at which a substrate-recognition camera should recognize the position and inclination of said individual substrate is controlled based on the result of the recognition of the circuit-formed substrate-securing condition.

5. A method for mounting a component, comprising the steps of:

recognizing the condition of a sucked component which is fed from a component-feeding unit, sucked and taken out;
recognizing the condition of a secured circuit-formed substrate which is carried, regulated and secured;
recognizing the position and inclination of at least one individual substrate provided by sectioning the circuit-formed substrate;
calculating correction amounts for the position and inclination of the component to be mounted, based on the results of the recognition of the component-sucking condition, the circuit-formed substrate-securing condition, and the position and inclination of the individual substrate; and
making necessary correction on the component based on the result of said calculation, and mounting the component at a predetermined position on the individual substrate;

wherein, when a portion or a whole of a mark provided on the circuit-formed substrate so as to recognize the circuit-formed substrate-securing condition, or a mark provided on the individual substrate so as to recognize the condition of the individual substrate is not included within the visual field of a substrate-recognition camera for recognizing these marks, the position of said mark is detected and said mark is again recognized.

6. The method according to claim 5, wherein the position of said mark is detected based on a portion of said mark captured within the visual field of the substrate-recognition camera, and said mark is again recognized by moving the visual field of the substrate-recognition camera to the detected position.

7. The method according to claim 5, wherein the position of said mark is detected by enlarging the visual field of the substrate-recognition camera, and said mark is again recognized.

8. A component-mounting apparatus comprising:

a component-feeding unit for feeding a component to be mounted;
a mounting head for taking the component out of the component-feeding unit and mounting it on a circuit-formed substrate;
a component-recognition camera for recognizing the condition of the component held by the mounting head;
an X-Y robot for carrying the mounting head to a predetermined position;
a circuit-formed substrate-securing device for carrying and securing the circuit-formed substrate;
a substrate-recognition camera for recognizing the condition of the secured circuit-formed substrate; and
a control unit for controlling the overall operations of the apparatus;

wherein said substrate-recognition camera recognizes an individual substrate mark which is provided on each of at least one individual substrate provided by sectioning the circuit-formed substrate so as to recognize the position and inclination of the individual substrate; correction amounts for the position and inclination of the component to be mounted are calculated based on the result of the recognition of the individual substrate mark, the result of the recognition of the component-holding condition by the component-recognition camera, and the result of the recognition of the circuit-formed substrate-securing condition by the substrate-recognition camera so as to make necessary correction on the component; and the mounting head is carried by the X-Y robot so as to mount the component at a predetermined position on the individual substrate;

wherein a bad mark to be indicated when the circuit-formed substrate includes a defective individual substrate is put on the individual substrate mark of the defective individual substrate so that the substrate-recognition camera can recognize the bad mark at the same time when recognizing the

individual substrate mark.

9. A component-mounting apparatus comprising:

a component-feeding unit for feeding a component to be mounted;
a mounting head for taking the component out of the component-feeding unit and mounting it on a circuit-formed substrate;
a component-recognition camera for recognizing the condition of the component held by the mounting head;
an X-Y robot for carrying the mounting head to a predetermined position;
a circuit-formed substrate-securing device for carrying and securing the circuit-formed substrate;
a substrate-recognition camera for recording and recognizing the condition of the secured circuit-formed substrate; and
a control unit for controlling the overall operations of the apparatus;

wherein said substrate-recognition camera recognizes an individual substrate mark which is provided on each of at least one individual substrate provided by sectioning the circuit-formed substrate so as to recognize the position and inclination of the individual substrate; correction amounts for the position and inclination of the component to be mounted are calculated based on the result of the recognition of the individual substrate mark, the result of the recognition of the component-holding condition by the component-recognition camera, and the result of the recognition of the circuit-formed substrate-securing condition by the substrate-recognition camera so as to make necessary correction on the component; and the mounting head is carried by the X-Y robot so as to mount the component at a predetermined position on the individual substrate,

wherein a position at which the substrate-recognition camera should recognize the individual substrate mark is controlled based on the result of the recognition of the circuit-formed substrate-securing condition.

10. A component-mounting apparatus comprising:

a component-feeding unit for feeding a component to be mounted;
a mounting head for taking the component out of the component-feeding unit and mounting it on a circuit-formed substrate;
a component-recognition camera for recognizing the condition of the component held by the mounting head;
an X-Y robot for carrying the mounting head to a predetermined position;
a circuit-formed substrate-securing device for carrying and securing the circuit-formed substrate;
a substrate-recognition camera for recording and recognizing the condition of the secured circuit-formed substrate; and
a control unit for controlling the overall operations of the apparatus;

wherein said substrate-recognition camera recognizes an individual substrate mark which is provided on each of at least one individual substrate provided by sectioning the circuit-formed substrate so as to recognize the position and inclination of the individual substrate; correction amounts for the position and inclination of the component to be mounted are calculated based on the result of the recognition of the individual substrate mark, the result of the recognition of the component-holding condition by the component-recognition camera, and the result of the recognition of the circuit-formed substrate-securing condition by the substrate-recognition camera so as to make necessary correction on the component; and the mounting head is carried by the X-Y robot so as to mount the component at a predetermined position on the individual substrate,

wherein, when a portion or a whole of a reference mark provided on the circuit-formed substrate for recognizing the circuit-formed substrate-securing condition, or an individual substrate mark is not included within the visual field of the substrate-recognition camera, the substrate-recognition camera detects the position of said mark and again recognizes said mark.

11. The apparatus according to claim 10, wherein the position of said mark is detected based on a portion of said mark captured within the visual field of the substrate-recognition camera, and said mark is again recognized by moving the visual field of the substrate-recognition camera to the detected position.

12. The apparatus according to claim 10, wherein the position of said mark is detected by enlarging the visual field of the substrate-recognition camera, and the detected mark is again recognized.

Fig.1A

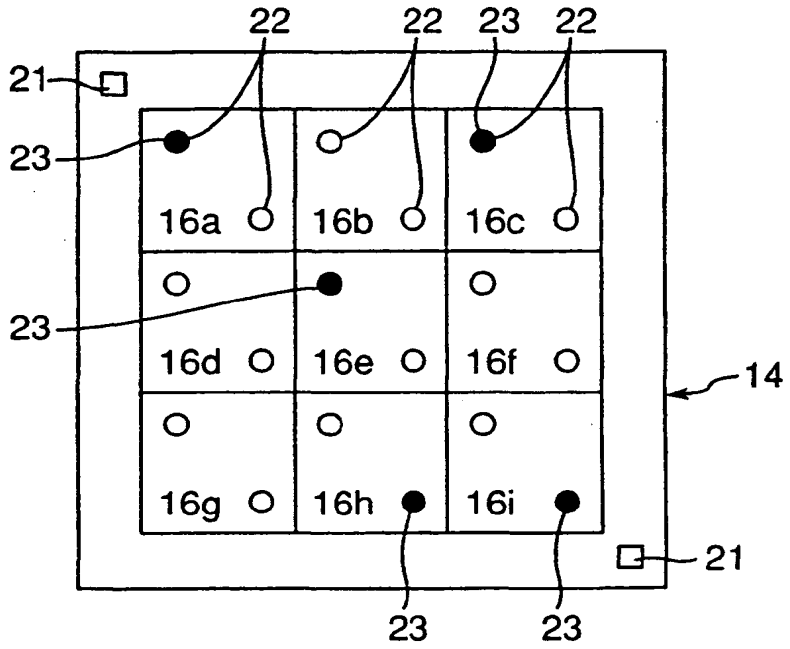


Fig.1B

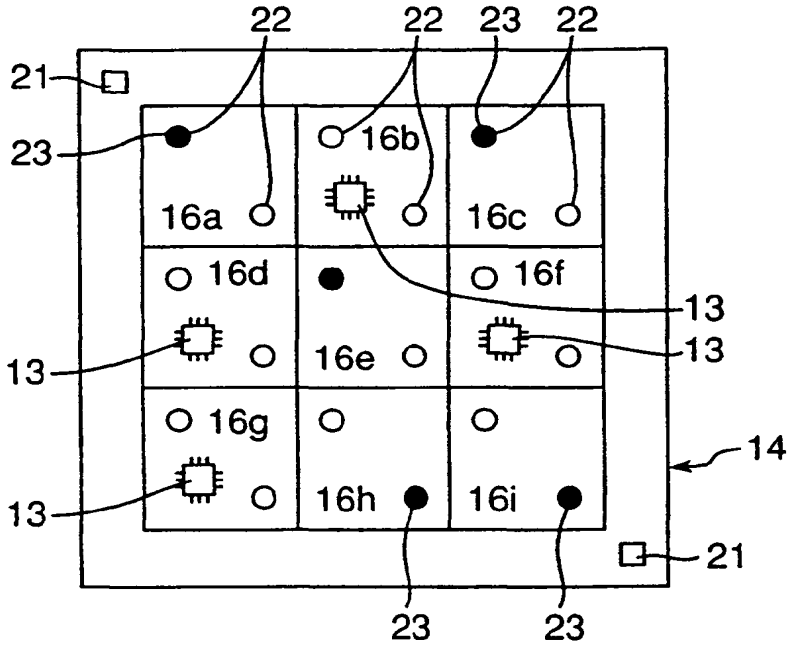


Fig.2

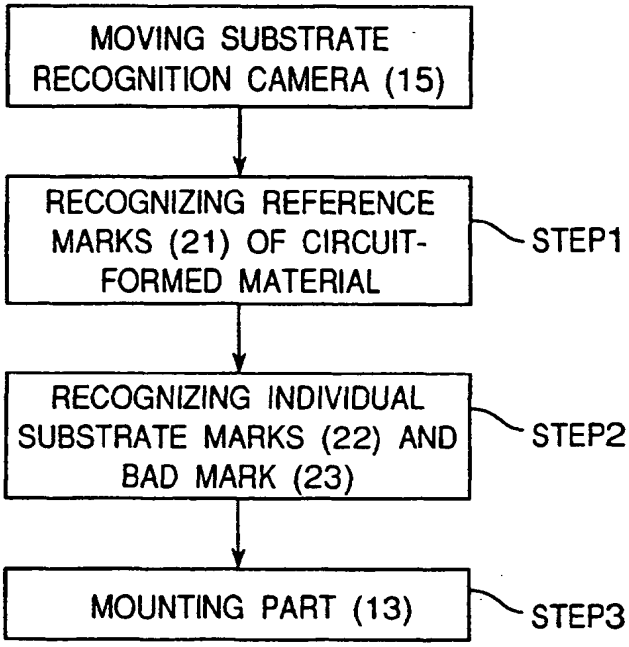


Fig.5

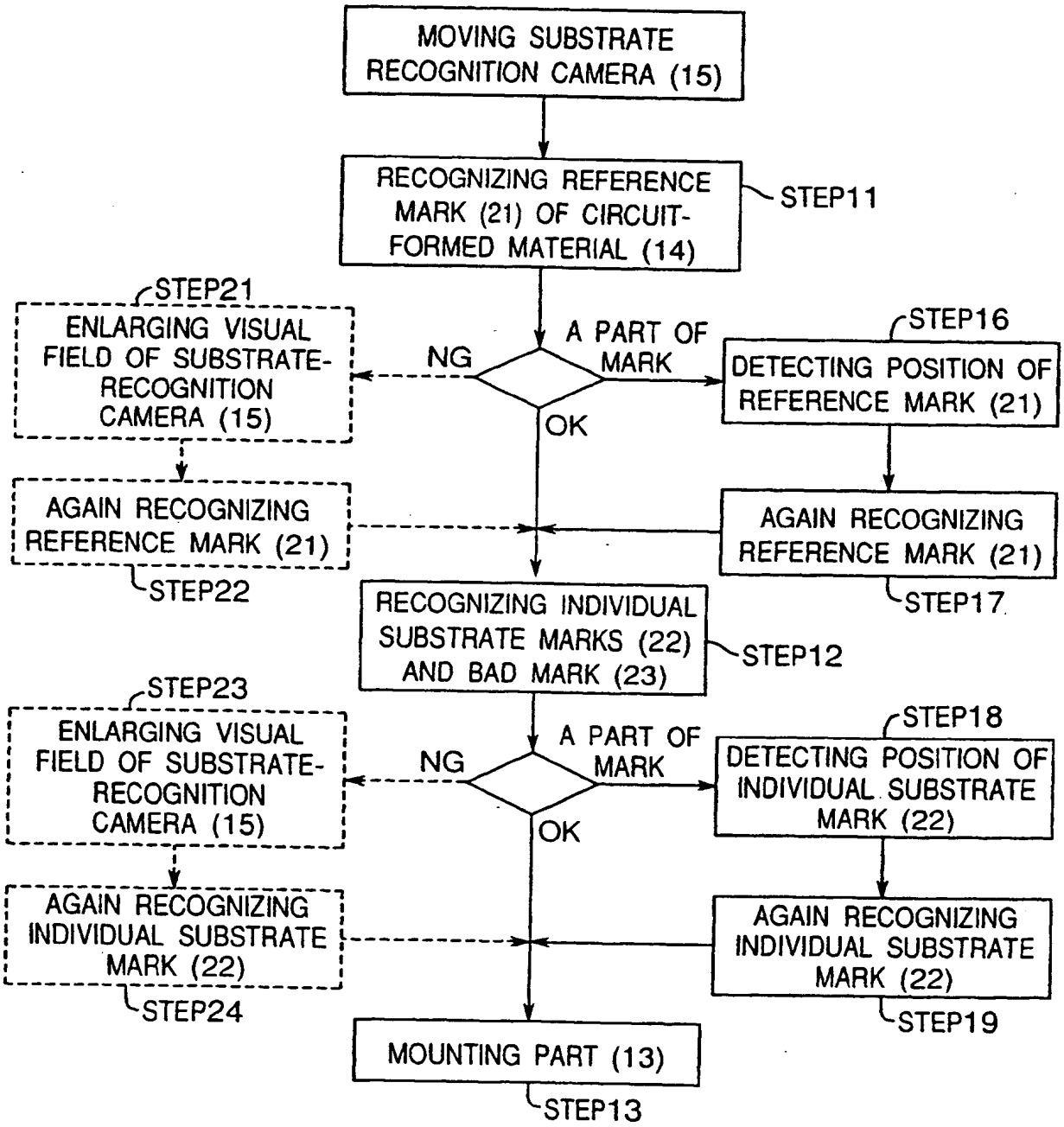


Fig. 6 PRIOR ART

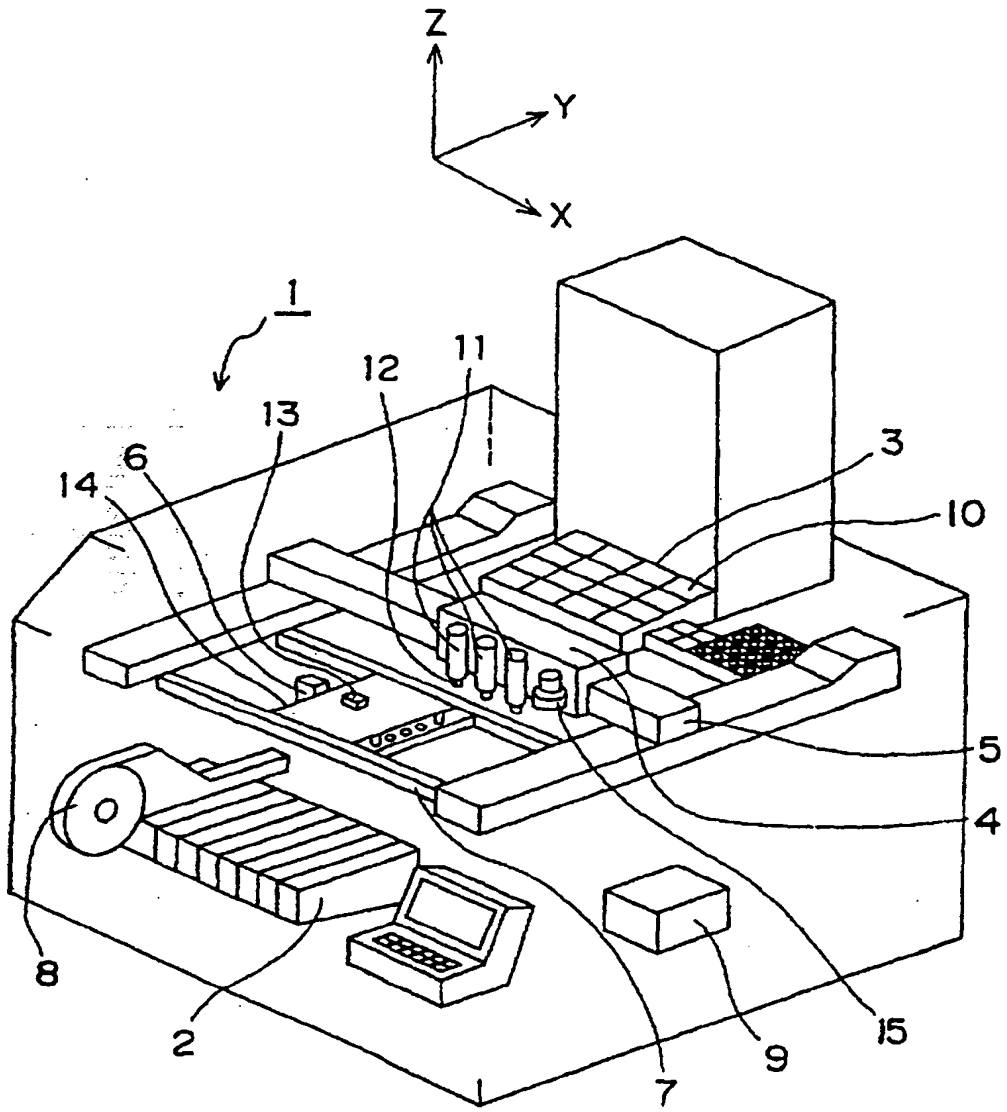


Fig.7A PRIOR ART

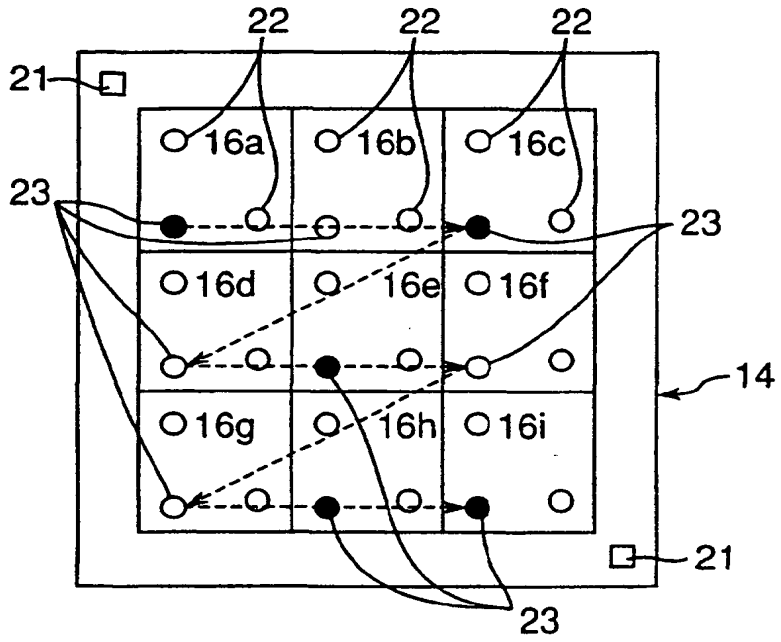


Fig.7B PRIOR ART

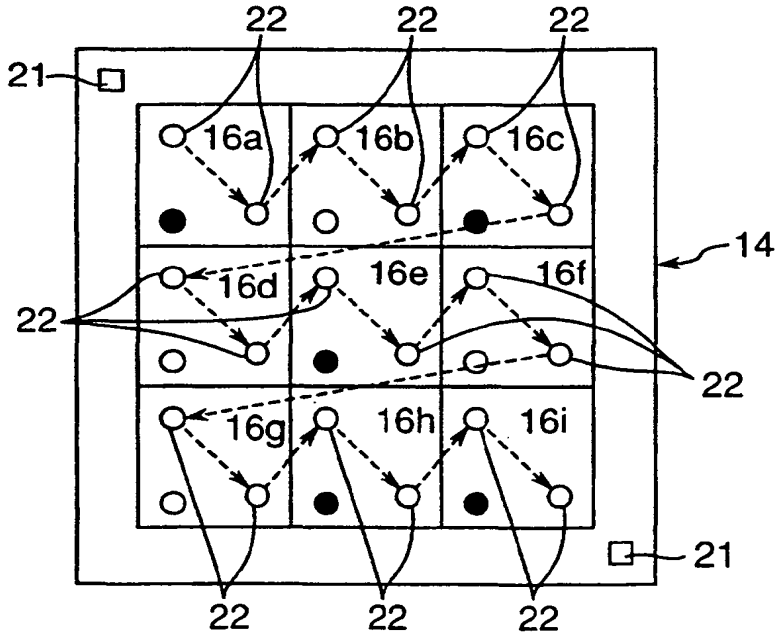


Fig.8 PRIOR ART

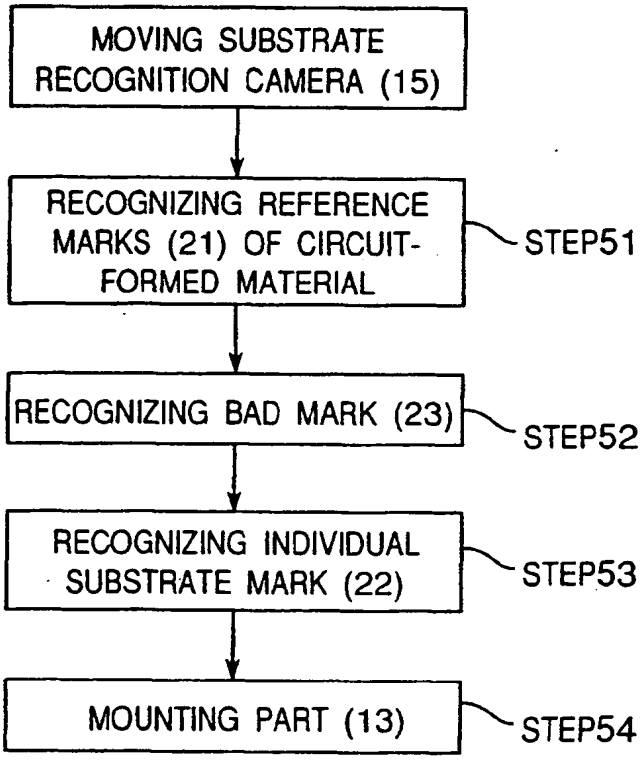


Fig.9 PRIOR ART